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THE WATER BEETLES OF BADANLOCH BOG, SUTHERLAND

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INTRODUCTION

The Flow Country of Caithness and Sutherland in northern Scotland is one of the largest intact areas of peatland in the world. Much of it is at low altitude and of international significance for nature conservation (Lindsay 1995). During 1994 and 1995, several large areas of blanket peat bog in Sutherland were sampled extensively to provide information on invertebrate distribution in relation to breeding wading birds in the Flow Country. This paper concentrates on the aquatic Coleoptera taken from a typical Flow Country bog area where studies of wading bird distribution, behaviour and diet were concurrent.

Much recent work has been carried out on the aquatic invertebrates from peatland areas in both Caithness and Sutherland (Spirit 1986, Foster 1988, Spirit and Ryrie 1991), and also from peatland habitats in the western Highlands and Mull (Foster *et al.* 1991). These studies surveyed wide geographical areas, sampling large estates or even vice-counties, and included other habitats as well as bog areas. The broad sampling areas covered resulted in a relatively low sampling effort or short time spent at each site. Even so, an extensive species list for the freshwater habitats in the north of Scotland has accumulated, including almost 100 species of aquatic Coleoptera. This study examined the species found within one pool system, and investigated the broad differences between the main bog pool types in more detail.

All samples in this study were taken from Badanloch Bog, a large blanket bog system in East Sutherland (V.C. 107; National Grid Reference NC 793329, 5.07km^2 area). Figure 1 shows the approximate location of the bog. In typical relatively undisturbed bog habitats, such as that found at Badanloch, there are several distinct types of pools, dependent on the overall size, drainage and catchment area of the bog. (Lindsay 1995; and Lindsay *et al.* 1988) describes the different pool types in detail. The present study concentrated on the two principal pool types found on Badanloch Bog; deep semi-permanent pools (Dubh Lochans, hereafter referred to as D-pools), typically found at the highest point of the bog surface, and shallow drought-sensitive pools (A-pools), most commonly found surrounding the Dubh Lochans. The vegetation surrounding both pool types was National Vegetation Classification type M18 (*Erica-Sphagnum* mire).

METHODS

Two principal trapping methods were used in order to sample invertebrates from both within the pools and from the surrounding vegetation. Water traps were developed to sample the abundance, species composition and possible emergence times of the aquatic invertebrates present in the main pool system, a habitat often selected by wading birds for feeding (Nethersole-Thompson and Nethersole-Thompson 1979). The water traps used were of a funnel and bottle design with a

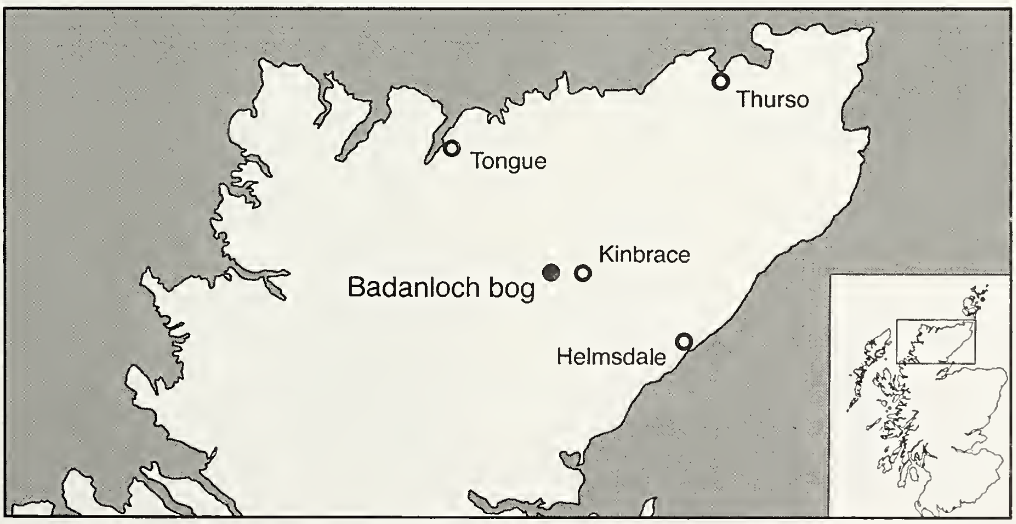

Figure 1. Approximate location of Badanloch Bog, Sutherland.

22mm circular entrance aperture, allowing easy access but limited or no escape once the invertebrates were trapped. The traps were orientated either vertically or horizontally within the water. Only vertical traps could be used in the A-pools owing to the relatively low water levels, and these traps were positioned with the funnel downwards. During 1994, 36 traps were operated simultaneously in different pools: 12 vertical in A-pools, 12 vertical and 12 horizontal in D-pools. During 1995 the number of traps was reduced to 24: six vertical in the A-pools, 18 horizontal in the D-pools (again, all in separate pools). These 18 horizontal D-pool traps were further split into six traps at the edges and six near the centre of the pools, and six traps at the edges with wire across the mouth of the trap to prevent the larger Dytiscidae species from entering. Any variation between the different traps placed within the D-pools will be described in more detail at a later date; only the presence of species in either pool type is described here. Traps were operated for three days after each of the dates shown in Table 1. All traps were tethered to a cane to prevent movement within the pool.

Table 1. Sampling dates for different trapping methods during 1994 and 1995. Water trap dates indicate start of a three day sampling period. Pitfall traps operated continuously, collections every 14-15 days.

	1994	1995
Water traps	14 May, 2 June, 17 June, 1 July, 13 July, 29 July and 24 October	18 April, 4 May, 18 May, 3 June, 19 June, 1 July and 15 July
Pitfall traps	4 April to 22 October	1 April to 29 October

Table 2. Aquatic Coleoptera taken in water traps and pitfall traps from Badanloch Bog during 1994 and 1995. A represents A-pools (shallow drought sensitive); D represents D-pools (large Dubh Lochans).

		Water traps		Pitfall traps	
		A	D	A	D
	DYTISCIDAE				
1	*Hydroporus erythrocephalus* (L.)	+	+		
2	*Hydroporus gyllenhalii* Schiödte	+			
3	*Hydroporus melanarius* Sturm			+	+
4	*Hydroporus obscurus* Sturm	+	+		
5	*Hydroporus pubescens* (Gyllenhal)	+			
6	*Hydroporus tristis* (Paykull)			+	
7	*Stictotarsus multilineatus* (Falkenström)		+		
8	*Platambus maculatus* (L.)			+	+
9	*Agabus arcticus* (Paykull)	+	+	+	+
10	*Agabus bipustulatus* (L.)	+	+	+	+
11	*Agabus congener* (Thunberg)	+	+	+	+
12	*Agabus montanus* (Stephens)	+			
13	*Ilybius aenescens* Thomson	+	+		
14	*Rhantus suturellus* (Harris)	+	+	+	
15	*Acilius sulcatus* (L.)		+		
16	*Dytiscus lapponicus* Gyllenhal		+		+
17	*Dytiscus marginalis* L.		+		
18	*Dytiscus semisulcatus* Müller		+		
	HYDROPHILIDAE				
19	*Megasternum obscurum* (Marsham)				+
20	*Anacaena globulus* (Paykull)			+	+
21	*Enochrus affinis* (Thunberg)	+		+	
22	*Enochrus fuscipennis* (Thomson)	+			
	CHRYSOMELIDAE				
23	*Plateumaris discolor* (Panzer)		+	+	
	Total number of species	12	13	10	8

Pitfall traps were used to sample the invertebrates from the surrounding pool vegetation (all traps approximately 1m from the water edge). Five traps (45mm mouth diameter, 2% formalin/detergent solution) were placed 2m apart in a straight line, set flush with the surface within the areas dominated by each pool type. The pitfall traps were in place continuously from early-April to late-October during both years (Table 1), and were emptied every 14-15 days.

RESULTS AND DISCUSSION

A total of 23 species of adult aquatic Coleoptera was found from both years combined, the majority belonging to the Dytiscidae, as shown in Table 2. Larvae were not identified. The total number of species taken from the A-pools was the same as the number found in the D-pools, i.e. 17, after combining both water and pitfall traps. Eleven species were taken only from water traps, and five were taken only from pitfall traps, suggesting a high degree of species separation between the water and the adjacent vegetation, as was expected. Six species were taken only from the A-pools and the surrounding area, and similarly six species were found only from the D-pool habitat.

Beetle size is probably one of the most important factors limiting species distribution between the two pool types, larger species requiring more space in which to swim (Ribera and Nilsson 1995), and in general these larger species were more common in the larger D-pools. The 23 species range from 1.5 mm to 35 mm in length (Joy 1932, Nilsson and Holmen 1995), though only six had a mean of >10 mm (*Agabus bipustulatus, Rhantus suturellus, Acilius sulcatus* and three *Dytiscus* species). Of these six, the last four (and also the largest four taken) were restricted to the D-pools. The first two were found in both pools types. In general, the smaller species taken were found in either or both pool types, suggesting they could utilise both habitat types to a greater degree than the larger species.

Figure 2 shows the seasonal distribution of adults of eight of the more commonly found species, expressed as a percentage of the total yearly catch for that species, from water traps only (A- and D-pools combined). Most of the species showed a peak in abundance or activity in May/June of both years. However *Agabus bipustulatus* shows a later peak in the 1994 catch (during July and still high in October) compared with the earlier peak in 1995 (during May). This may be due to variation in the seasonal temperature between years. Only one species showed a consistent peak in adult abundance later in the season compared with the majority of the other species; *Ilybius aenescens* had peaks in abundance in late June and July. Only *A. bipustulatus* and *Dytiscus marginalis* appeared to remain active during October (more than 10% of the 1994 catch taken during October sampling period), although a few specimens of *A. arcticus* and *D. lapponicus* were taken. The seasonal patterns of the species described above were broadly similar to their seasonal catches in the pitfall traps.

Although only 23 species of aquatic or semi-aquatic Coleoptera were found during this survey compared with nearly 100 species known for the Flow Country area, it nevertheless indicates a more diverse habitat than was previously thought. The intensive and long-term sampling of a relatively small area, coupled with variation in sampling methods have proven beneficial in gaining a fuller picture of the species present. One drawback of collecting species lists from water traps such as used in this study is the bias for species from within the water body, with species which are more active on the water surface (e.g. Gyrinidae) being under-represented. Nevertheless, the methods used here have proven to be an effective and relatively low-mainenance way of sampling the aquatic fauna.

Most of the species collected are considered typical for these types of habitat, and the list did not include any species which had not been found in similar habitats by other workers elesewhere in the north of Scotland. *Dytiscus lapponicus*, *Megasternum obscurum* and *Plateumaris discolor* are considered new records for East Sutherland, though this may be a reflection of the large area and volume of inland freshwater coupled with the small number of studies, rather than an influx of new species to the area. Four species are considered Nationally Notable B in their status according to Hyman and Parsons (1992, 1994); *Stictotarsus multilineatus*, *Ilybius aenescens*, *Dytiscus lapponicus* and *Enochrus affinis*. During 1995, horizontal water traps were also placed at the edge of nearby Loch Achnamoine (NGR NC 810324) which bordered

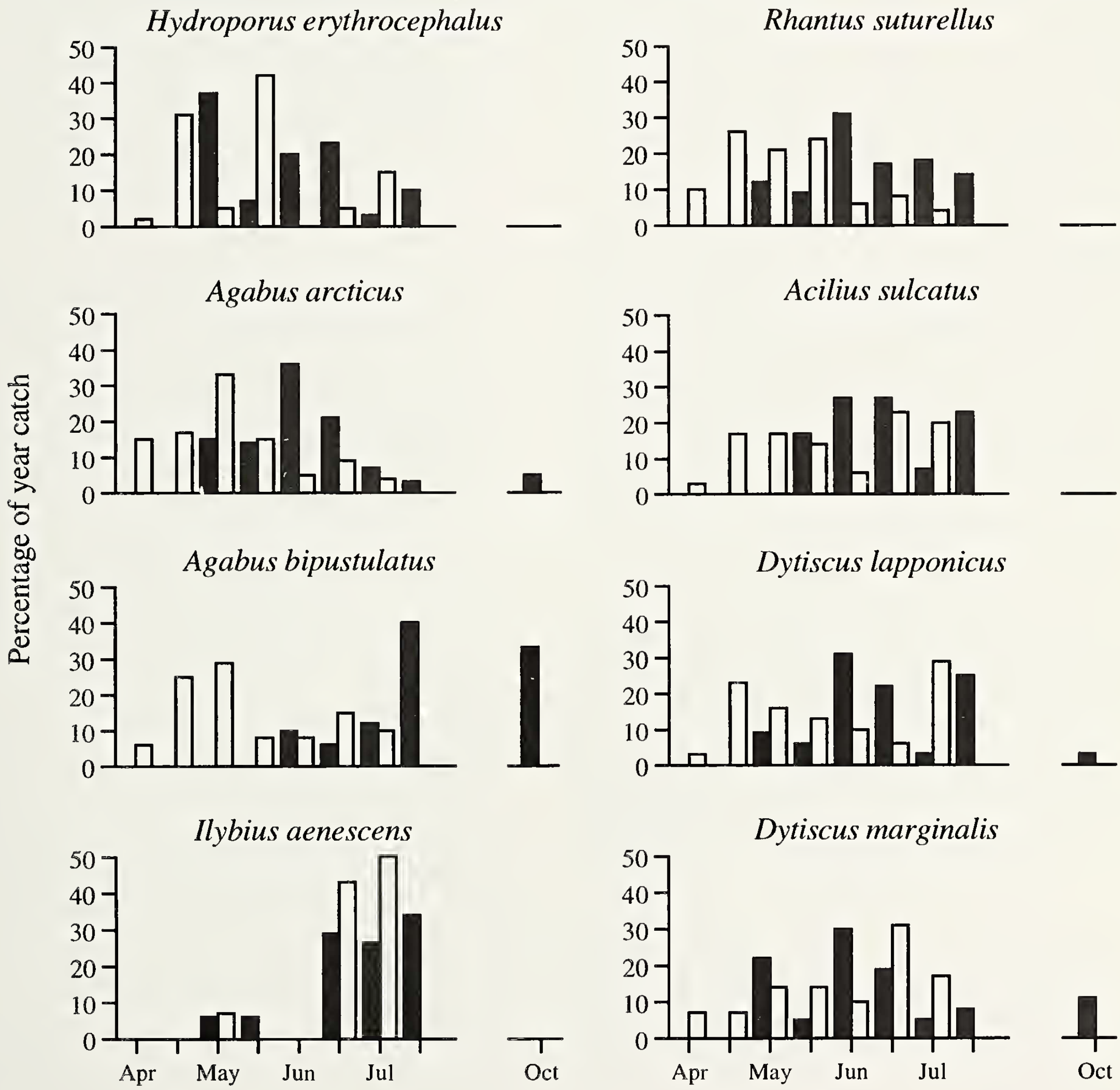

Figure 2. Seasonal distribution of the more commonly trapped species (>40 specimens (in water traps only) over two years) expressed as a percentage of the total year catch of that species. Dark bars are 1994 catch, white bars are 1995 catch.

the bog. However, they were subject to damage from wind-fetch and otters, and were discontinued (only one trap worked during the first period). Only one species of water beetle was collected during this period, *Oreodytes alpinus* (Paykull). This species has only recently been found in Britain (Foster and Spirit 1986). It is more common in northern Fennoscandia and probably Siberia (Foster 1986), and is classed as RDB3 (Hyman and Parsons 1992, 1994). The western sandy edge of the loch from which the species was taken was typical of other localities where it has been found previously (Foster 1986). It seems likely therefore that the water beetle fauna of the bog area is very similar to that of other Holarctic areas, and is of interest due to its possible arctic-alpine characteristics (Lindsay *et al.* 1988).

The pool systems and surrounding vegetation provide a potential food source for breeding birds such as greenshank, dunlin and golden plover, and as such are important conservation features. The wader breeding distribution coincides generally with increases and seasonal peaks in abundance of the water beetles in and around the pools, and evidence from dietary studies indicates that aquatic Coleoptera make up an important part of the waders' diet, especially that of greenshank (Downie *et al.* 1996). The D-pools are the most important and predictable food reservoir during the breeding season as they are the least influenced by drought, the A-pools being more susceptible to dry summer conditions (Lindsay *et al.* 1988). This might in part explain why most of the British greenshank population (c. 66%) resides in the Caithness-Sutherland region, as the bog surface pool-structure further south or in the extreme west is made up of smaller pools which are subsequently more drought sensitive (Lindsay *et al.* 1988). Ironically, the structure of the D-pools usually makes wading difficult for birds as they are usually deep, sharp-sided lochans. However, summer weather often reduces the water level, making wading possible. In wetter years, the birds would presumably use the shallower A-pools, or wade around the sides of larger lochs or river shallows to obtain the aquatic component of their diet.

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